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EXAMINER
KIELIN, ERIK J

ART UNIT	PAPER NUMBER
2813	19

DATE MAILED: 09/24/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/597,076	Applicant(s) CHEN ET AL.	
	Examiner Erik Kielin	Art Unit 2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 August 2002* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,2,4-6,8-16,18-27,30 and 31* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,4-6,8-16,18-27,30 and 31* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☒ The proposed drawing correction filed on *12 August 2002* is: a)☒ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *15* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Drawings

1. The proposed drawing correction and/or the proposed substitute sheets of drawings, filed on 8/12/02 have been approved.

INFORMATION ON HOW TO EFFECT DRAWING CHANGES

1. Correction of Informalities -- 37 CFR 1.85

New corrected drawings must be filed with the changes incorporated therein. Identifying indicia, if provided, should include the title of the invention, inventor's name, and application number, or docket number (if any) if an application number has not been assigned to the application. If this information is provided, it must be placed on the front of each sheet and centered within the top margin. If corrected drawings are required in a Notice of Allowability (PTOL-37), the new drawings **MUST** be filed within the **THREE MONTH** shortened statutory period set for reply in the "Notice of Allowability." Extensions of time may NOT be obtained under the provisions of 37 CFR 1.136 for filing the corrected drawings after the mailing of a Notice of Allowability. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

2. Corrections other than Informalities Noted by Draftsperson on form PTO-948.

All changes to the drawings, other than informalities noted by the Draftsperson, **MUST** be made in the same manner as above except that, normally, a highlighted (preferably red ink) sketch of the changes to be incorporated into the new drawings **MUST** be approved by the examiner before the application will be allowed. No changes will be permitted to be made, other than correction of informalities, unless the examiner has approved the proposed changes.

Timing of Corrections

Applicant is required to submit acceptable corrected drawings within the time period set in the Office action. See 37 CFR 1.185(a). Failure to take corrective action within the set (or extended) period will result in **ABANDONMENT** of the application.

A proper drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The correction to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

3. Claims **1**, 2, 4, 6, 8-11, 13-14 and **16**, 19, 20, 23, 30 rejected under 35 U.S.C. 102(e) as being anticipated by US 6,316,300 B1 (**Ozeki** et al.).

Regarding claims 1, 2, 4, 16, 20, 23, and 30, **Ozeki** discloses a process for fabricating an oxide comprising (a) forming a first oxide portion **6a** over a silicon substrate by oxidation at a first temperature of 875 °C which is below the viscoelastic threshold temperature (925 °C as indicated in the instant specification at p. 8, lines 25-27); (b) forming a second oxide portion **6** under said first oxide portion by oxidation at a temperature of 1050 °C; and (c) cooling said

substrate at a controlled rate of 3 °C/min to a temperature below the viscoelastic temperature (800 °C) so that said first oxide portion acts as a stress sink for said second oxide portion, as indicated by Applicant in the specification at p. 9, lines 1-15. (See Figs. 6A-6B and associated text col. 8, line 36 to col. 9, line 34.)

Additionally regarding claims 1 and 16, and also regarding claims 6 and 19, the silicon substrate is heated from the initial temperature of normal room temperature to 800 °C ("the first temperature") at a first ramp rate, and then to 875 °C ("the temperature below the threshold temperature [of 925 °C]") at a rate of 10 °C/min (col. 8, lines 43-46).

Additionally regarding claims 1 and 16, regarding claims 8-10, the ambient temperature is 875 °C, the third rate and fourth rates are 10 °C/min, as further limited in claims 9 and 10, and the temperature above the threshold temperature is 1050 °C, as further limited by instant claim 8 (col. 9, lines 1-5). Note that there is no requirement disclosed or claimed that the third and fourth rates be different. Rather the claims 9 and 10 clearly indicate that the rates are exactly the same over most of the claimed ranges. Also note, in pertinent part, that because the temperature is ramped there necessarily exist an infinite number of temperatures to which the silicon substrate is heated in the continuum between the oxidation temperature below to that oxidation temperature above the threshold temperature.

Regarding claim 11, the oxidizing ambient is oxygen and/or steam (Fig. 6B; col. 8, lines 53-67.)

Regarding claims 13 and 14, the temperature is reduced from 1050 °C to 800 °C at 3 °C/min and then "unloaded from the oxidation reactor" which will result in the cooling at a second rate to normal room temperature (Fig. 6A; col. 9, lines 26-33).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims **1**, 2, 4, 8-11, 13, 14, and **16**, 20, 23, 30 are rejected under 35 U.S.C. 103(a) as unpatentable over US 4,518,630 (**Grasser** et al.) in view of US 5,817,581 (**Bayer** et al.).

Regarding claims 1, 2, 4, 16, 20, 23, and 30, **Grasser** discloses a process for fabricating an oxide comprising (a) forming a first oxide portion over a silicon substrate by oxidation at a first temperature of 700-900 °C which is below the viscoelastic threshold temperature of 925 °C to form an oxide portion 1 nm (10 Å) thick (Fig.; col. 2, lines 60 to end); (b) forming a second oxide portion under said first oxide portion by oxidation at a temperature of 1000 °C in an oxidizing ambient of oxygen; and (c) eventually cooling the wafer to a temperature of 850 °C below the threshold temperature at a rate of 1.7 to 3.3 °C/min as is clear from the data and then "taken out" of the furnace which allows cooling at a second rate, as further limited by claims 13 and 14 (col. 3, lines 33-39). (See Fig. and col. 2, line 50 to col. 3, line 64.)

Grasser, as explained above, discloses each of the claimed features except for using a first and a second rate to heat the substrate to the temperature below the threshold temperature of

700-900 °C or using a third and fourth ramp rate to heat to the temperature above the threshold temperature.

Bayer teaches a multi-step oxidation process wherein the substrate is heated to the first low oxidation temperature (the temperature below the threshold temperature of 925 °C) at a first rate of 7 °C/min to a first temperature and then from the first temperature at a second rate of 1 °C/min to the temperature below the threshold temperature, which provides better temperature control and prevents overshooting the temperature. (See col. 2, lines 18-27.) Such a two-ramp-rate heating would also apply for any change in oxidation temperature, such as the heating of the substrate to from the temperature below to the temperature above the threshold temperature, in order to gain faster heating rates and better temperature control, as taught in **Bayer**. Note however, that Applicant has no requirement that the rates between different and actually claims significantly overlapping 3rd and 4th ramp rates in claims 9 and 10.

Note impertinent part the Applicant's first temperature is merely the temperature at which the temperature ramp rates are changed. See Applicant's Fig. 2B the intersection between lines 21 and 22 which is only a point. In other words, there exists no dwell at the instantly claimed "first temperature." Accordingly, the point in **Bayer** at which the ramp rates change is necessarily the same as the instantly claimed "first temperature."

It would be obvious for one of ordinary skill in the art, at the time of the invention, to use a two-ramp-rate heating process as taught by **Bayer** to heat to the oxidation temperature below the threshold temperature and another two-ramp-rate heating process to heat to the oxidation temperature above the threshold temperature in **Grasser** in order to provides a faster heating

process than using a single rate and to provide better temperature control, which prevents overshooting the temperature, as is clear from the teaching in **Bayer**.

Regarding claims 8-10, **Grasser** discloses the ambient temperature is 700-900 °C, the first rate and second rates are 10 °C/min, as further limited in claims 9 and 10, and the temperature above the threshold temperature is 1000 °C, as further limited by instant claim 8 (col. 3, lines 20-26). Note that there is no requirement disclosed or claimed that the first and second rates be different. Rather the claims 9 and 10 clearly indicate that the rates are exactly the same over most of the claimed ranges.

Regarding claim 11, **Grasser** discloses the oxidizing ambient is oxygen and/or steam (col. 3, lines 15-16).

6. Claims **1** and 12 are rejected under 35 U.S.C. 102(b) as being unpatentable over US 4,826,779 (**Wright** et al.) in view of US 5,817,581 (**Bayer** et al.).

Wright discloses a process for fabricating an oxide comprising (a) forming a first oxide portion **32a-c** over a silicon substrate by oxidation at a first temperature of 900 °C which is below the viscoelastic threshold temperature (925 °C); (b) forming a second oxide portion **36a-c** under said first oxide portion by oxidation at a temperature of 1050 °C in an oxidizing ambient of 10% oxygen, as further limited by instant claim 12; and (c) eventually cooling the wafer to a temperature below the threshold temperature. (See Figs. 2-3; col. 4, lines 11-35.)

The prior art of **Wright**, as explained above, discloses each of the claimed features except for using a first and a second rate to heat the substrate to the temperature below the

threshold temperature of 900 °C, using a third and fourth ramp rate to heat to the temperature above the threshold temperature.

Bayer teaches a multi-step oxidation process wherein the substrate is heated to the first low oxidation temperature (the temperature below the threshold temperature of 925 °C) at a first rate of 7 °C/min to a first temperature and then from the first temperature at a second rate of 1 °C/min to the temperature below the threshold temperature, which provides better temperature control and prevents overshooting the temperature. (See col. 2, lines 18-27.) Such a two-ramp-rate heating would also apply for any change in oxidation temperature, such as the heating of the substrate to from the temperature below to the temperature above the threshold temperature, in order to gain faster heating rates and better temperature control, as taught in **Bayer**. Note however, that Applicant has no requirement that the rates between different and actually claims significantly overlapping 3rd and 4th ramp rates in claims 9 and 10.

Note impertinent part the Applicant's first temperature is merely the temperature at which the temperature ramp rates are changed. See Applicant's Fig. 2B the intersection between lines 21 and 22 which is only a point. In other words, there exists no dwell at the instantly claimed "first temperature." Accordingly, the point in **Bayer** at which the ramp rates change is necessarily the same as the instantly claimed "first temperature."

It would be obvious for one of ordinary skill in the art, at the time of the invention, to use a two-ramp-rate heating process as taught by **Bayer** to heat to the oxidation temperature below the threshold temperature and another two-ramp-rate heating process to heat to the oxidation temperature above the threshold temperature in **Wright** in order to provides a faster heating

process than using a single rate and to provide better temperature control, which prevents overshooting the temperature, as is clear from the teaching in **Bayer**.

7. Claims 5, 18, 22, and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Ozeki** in view of US 6,207,591 B1 (**Aoki** et al.).

The prior art of **Ozeki**, as explained above, discloses each of the claimed features except for indicating a first heating rate of 50 °C to 125 °C to the disclosed first temperatures in the range of 750 °C to 850 °C.

Aoki teaches that conventional furnaces typically heat at rates of 1 °C/min to 100 °C/min, typically at 50 °C/min to reach an initial heating temperature. **Aoki** also teaches that conventional furnaces typically cool at 50 °C/min. **Aoki** also teaches that stepwise changes in the heating a cooling rates conventionally depend upon the "temperature region of the heating and cooling operation" as has already been shown in the applied art. (See paragraph bridging cols. 1-2, and prior art Fig. 1.)

It would be obvious for one of ordinary skill in the art, at the time of the invention, to modify the heating rate of **Ozeki** for the heating to the first heating temperature of 800 °C taught therein, at a first rate of 50 °C/min or 100 °C/min and to cool at the second rate of the wafer pull at 50 °C/min, both as taught in **Aoki**, because **Ozeki** does not teach what the first heating rate or the second cooling rate is, so that one of ordinary skill would be motivated to find and to use conventional rates which provide good results, such as the conventional rates in **Aoki**, and because the rates are high which would reduce thermal budget which is always highly desired in the art.

8. Claims 5, 18, 22, 25 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Grasser** in view of **Bayer** as applied to claims 1 and 16 above, and further in view of US 6,207,591 B1 (**Aoki** et al.).

The prior art of **Grasser** in view of **Bayer**, as explained above, discloses each of the claimed features except for indicating a first heating rate of 50 °C to 125 °C to the disclosed first temperatures in the range of 750 °C to 850 °C.

Aoki teaches that conventional furnaces typically heat at rates of 1 °C/min to 100 °C/min, typically at 50 °C/min to reach an initial heating temperature. **Aoki** also teaches that conventional furnaces typically cool at 50 °C/min. **Aoki** also teaches that stepwise changes in the heating and cooling rates conventionally depend upon the "temperature region of the heating and cooling operation" as has already been shown in the applied art. (See paragraph bridging cols. 1-2, and prior art Fig. 1.)

It would be obvious for one of ordinary skill in the art, at the time of the invention, to modify the heating rate of **Grasser** in view of **Bayer** to cool at the second rate of the wafer pull at 50 °C/min, as taught in **Aoki**, because **Grasser** in view of **Bayer** does not teach what the second cooling rate is, so that one of ordinary skill would be motivated to find and to use conventional rates which provide good results, such as the conventional rates in **Aoki**.

Regarding claim 25, note that **Grasser** teaches that the first oxide portion is 1 nm (10 Å), as noted above.

9. Claims 15 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over either of **Ozeki** and **Grasser**, either in view of **Wolf**, et al. Silicon Processing for the VLSI Era, Vol. 1-Process Technology, Lattice Press: Sunset Beach CA, 1986, p. 5.

The prior art of each of **Ozeki** and **Grasser**, as explained above, discloses each of the claimed features except for indicating that the silicon substrate is monocrystalline.

Wolf teaches the benefits of using monocrystalline silicon to form semiconductor devices because monocrystalline has higher carrier mobility than in polycrystalline silicon thereby affording higher speed devices, which is always highly desired in the art.

It would be obvious for one of ordinary skill in the art, at the time of the invention, to use monocrystalline silicon as the substrates in any of **Ozeki** and **Grasser** to have higher speed devices as taught by **Wolf**.

Allowable Subject Matter

10. Claims 21, 26, and 27 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claim 21 also requires overcoming the rejection under 35 USC 112(1), as noted above.

The following is a statement of reasons for the indication of allowable subject matter:

Regarding claim 21, the prior art of record does not fairly teach or suggest the specific combination of steps claimed therein, in combination with the other claimed features. Note however, that **Ozeki** does teach the first two steps recited in instant claim 21, wherein the oxygen concentration during the heating rates is between 0-5% oxygen, but fails to teach that the oxygen

concentration of 0-25% is used to form the second oxide portion. **Ozeki** uses higher concentrations of oxygen during the second oxidation step.

Regarding claim 26, although Grasser teaches that the first portion of the oxide is 10 Å, Grasser also teaches that a second portion of 1 nm is grown during the ramp from the first oxidation temperature to second, and that a third portion is grown to a desired thickness of 50 100 Å which would require the oxidation at the higher portion to be formed to a minimum of 30 Å which is not in the range of 2-12 Å.

Regarding claim 27, the prior art of record does not teach forming a 15 Å oxide using the two-step oxidation process as claimed.

Response to Arguments

11. Applicant's arguments filed 12 August 2002 have been fully considered but they are not persuasive.

Applicant argues that **Ozeki** does not teach two ramp rates. Examiner respectfully disagrees. There is simply no way to heat the silicon substrate to 800 °C without a ramp rate. Accordingly, Applicant's argument is necessarily in error. Also note that Applicant has not indicated that the ramp rates must be different, especially the third and fourth ramp rates which particularly overlap significantly. Accordingly the third and fourth ramp rates may be exactly the same and the that the silicon substrate is necessarily heated to all temperatures between the temperature below and the temperature above the threshold temperature at those third and fourth rates.

Applicant argues that Grasser in combination with Bayer does not teach each of the features of the claims. Examiner respectfully disagrees for the reasons indicated in the rejection

above. In pertinent part, Applicant appears to argue that the first temperature between the first and second ramp rates or the temperature between the third and fourth ramp rates is not taught. Note that Grasser in view of Bayer teaches these intermediate temperatures to every extent that Applicant discloses in the instant specification. It is simply not possible to get from one temperature to another by skipping temperatures along the way. The change by the laws of nature is a continuum. That Applicant has indicated that "the first temperature" is the temperature at which the ramp rates change is necessarily taught in Bayer. Furthermore, the combination of Grasser and Bayer is proper for the reasons indicated. Note that Examiner does not have to have the same reason for combining the references as Applicant has. Applicant has not addressed why the reason for combining the Grasser and Bayer references, as indicated by Examiner, is somehow improper.

The remaining arguments are moot in view of the new grounds of rejection.

Conclusion

12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37

CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication from examiner should be directed to Erik Kielin whose telephone number is (703) 306-5980 and e-mail address is erik.kielin@uspto.gov. The examiner can normally be reached by telephone on Monday through Thursday 9:00 AM until 7:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri, can be reached at (703) 306-2794 or by e-mail at olik.chaudhuri@uspto.gov. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

EK

September 21, 2002

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